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(54) **SYSTEM AND METHOD FOR HOUSING TELECOMMUNICATIONS EQUIPMENT**

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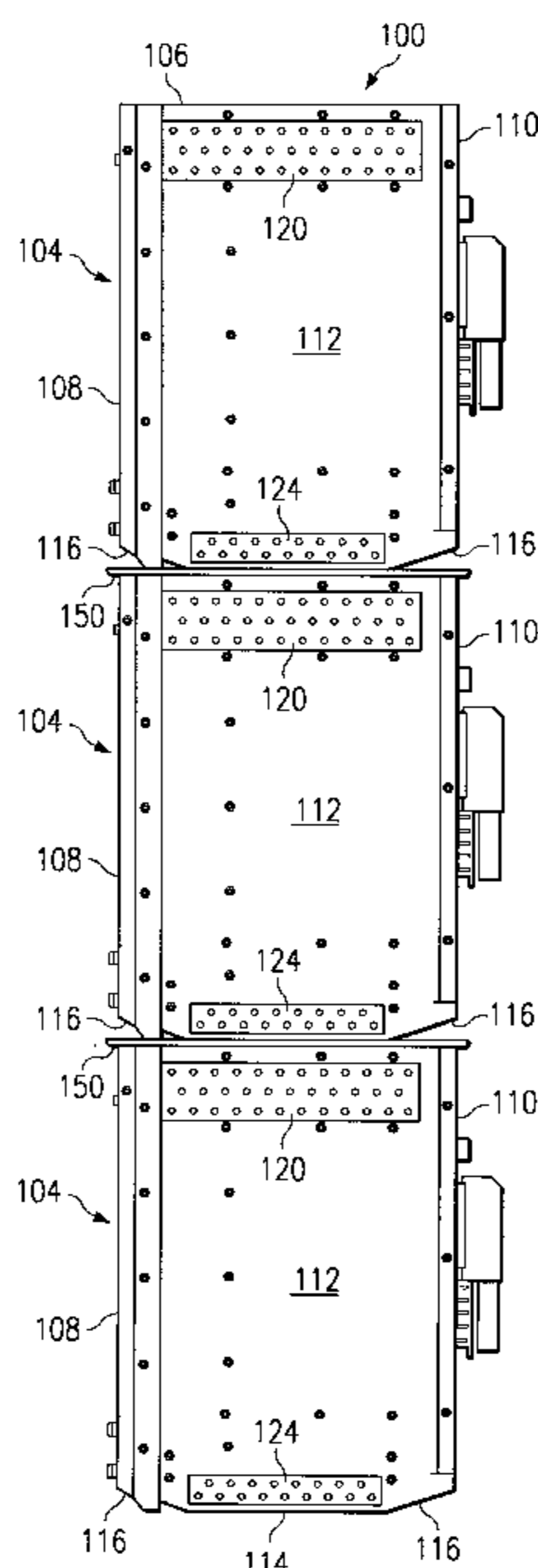
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(57) **ABSTRACT**

A system for housing telecommunications equipment includes a plurality of vertically disposed chassis, each chassis having a top that is substantially closed, two sides, two ends, and a base, wherein the top of each chassis is adapted to receive the base of an adjacent chassis. At least one vent is formed in each chassis adjacent the base for allowing air to enter the chassis, and at least one of the ends and one of the sides of the chassis are formed such that air may exit the chassis. The vent is disposed between the base and a portion of the chassis selected from the group consisting of either of the ends and either of the sides, and the vent is nonplanar in relation to that portion. More specifically, the chassis may be vertically disposed with substantially zero gap, and the vent member may be either an angled vent member or a notched vent member.

25 Claims, 2 Drawing Sheets



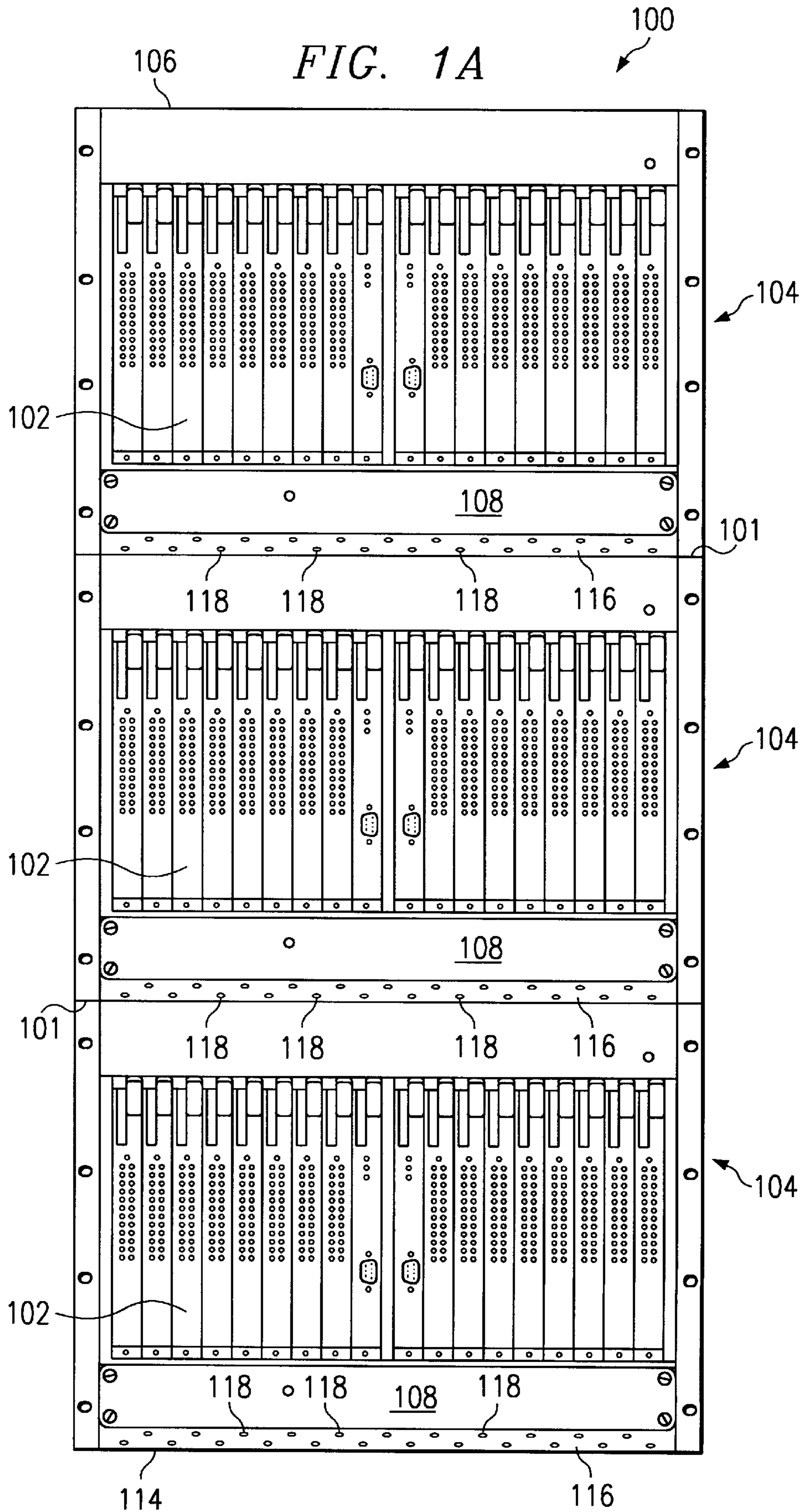


FIG. 1B

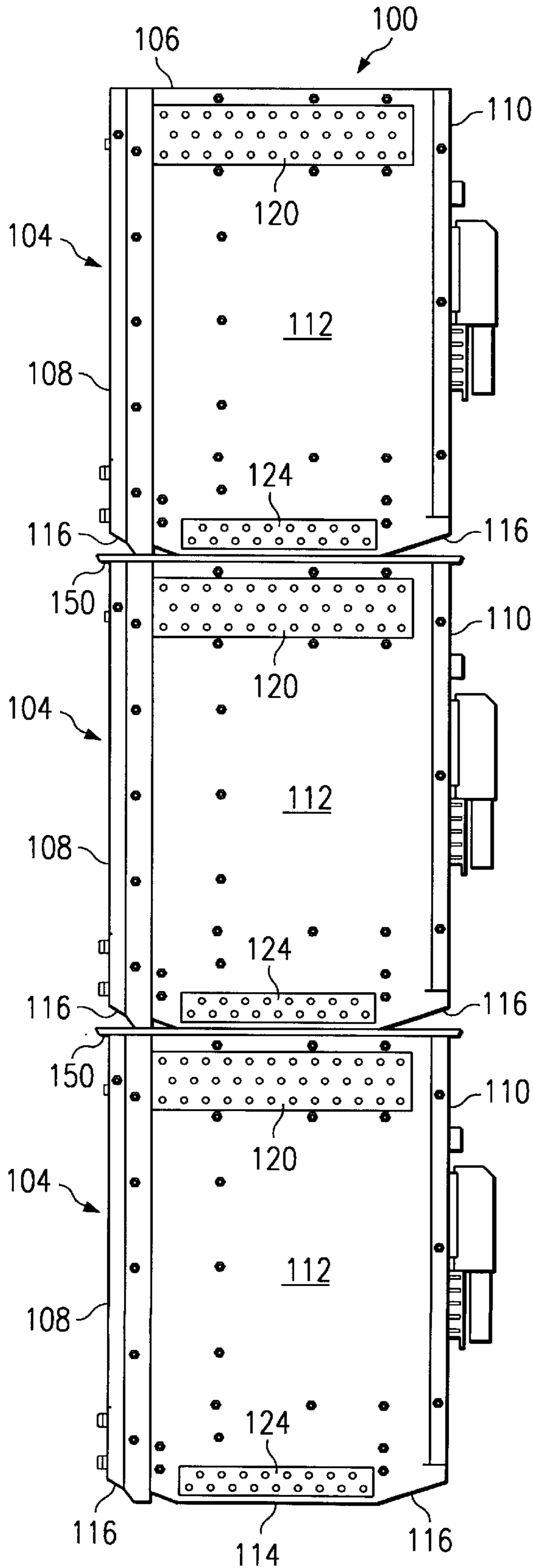


FIG. 2A

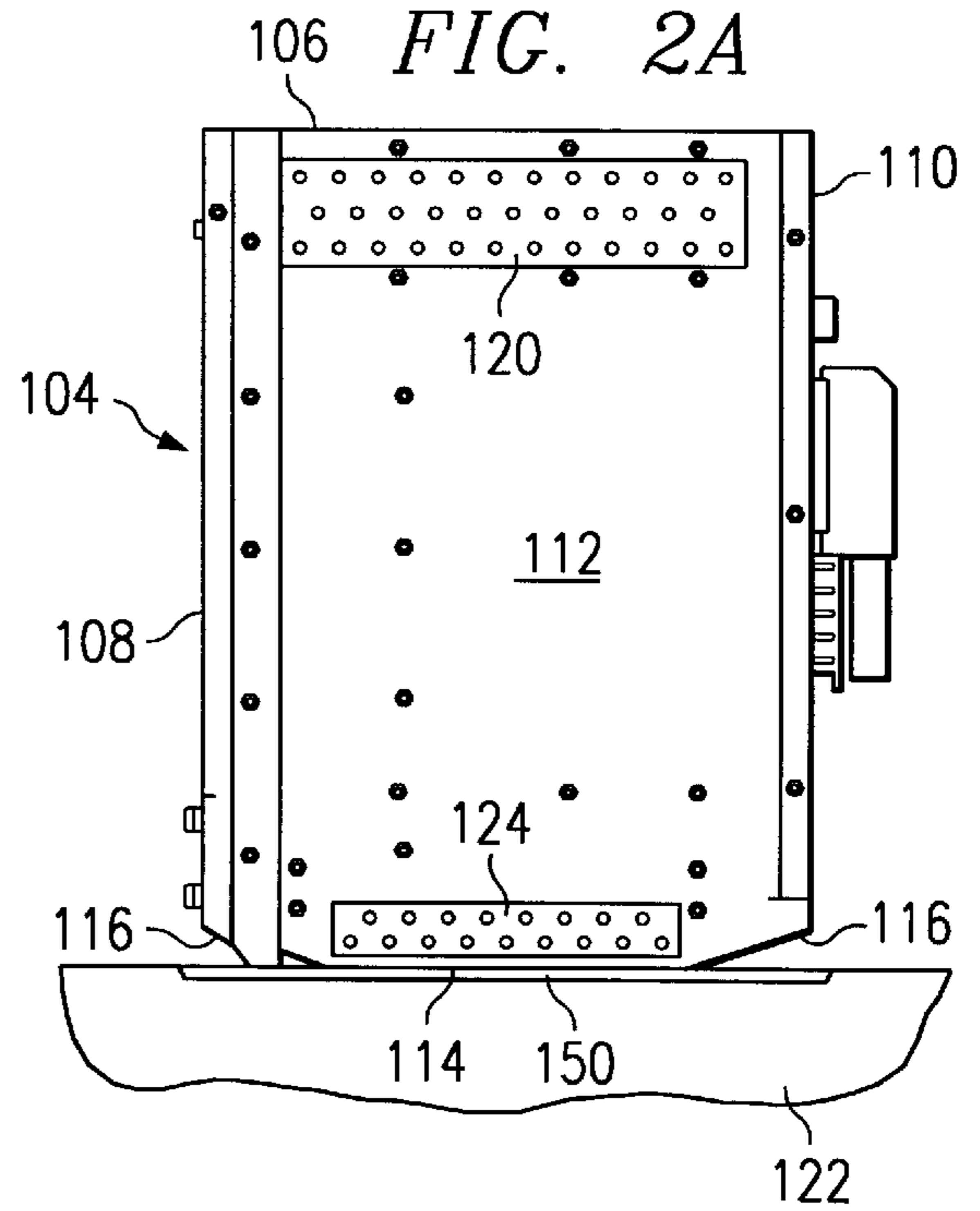
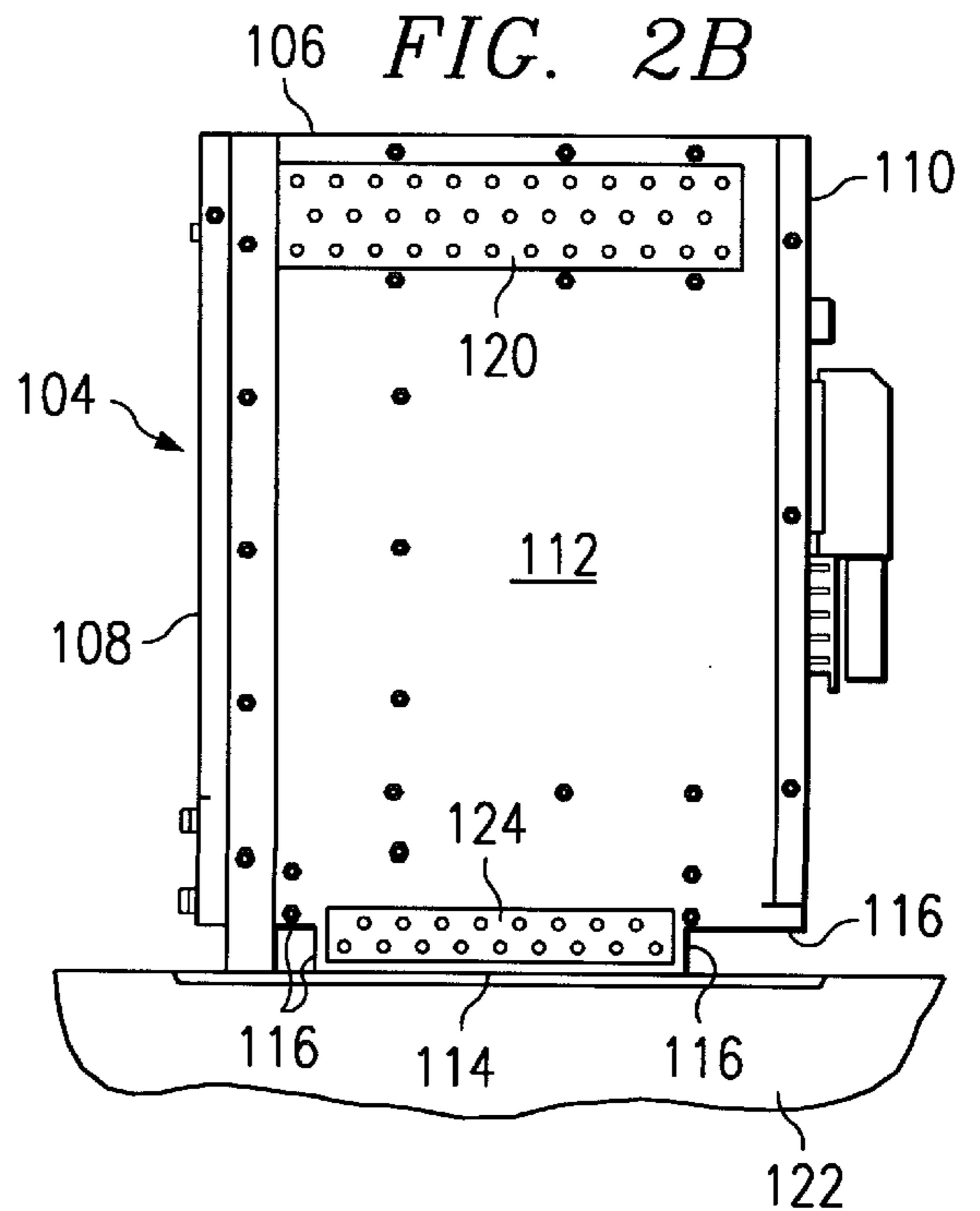


FIG. 2B



SYSTEM AND METHOD FOR HOUSING TELECOMMUNICATIONS EQUIPMENT

TECHNICAL FIELD OF THE INVENTION

This invention relates generally to the field of telecommunications and, more specifically, to a system and method for housing telecommunications equipment.

BACKGROUND OF THE INVENTION

Chassis are frameworks used to house telecommunications equipment, and are often found in a room or other area where, for example, switching takes place. This other room or area is often referred to as a "central office environment." When stacking chassis in a central office environment, important considerations include, among others, the proper cooling of each chassis, the efficient stacking of chassis to avoid wasted space, and meeting certain environmental requirements. The installer of telecommunication equipment has to be certain that lower chassis do not preheat upper chassis or that upper chassis do not block air flow from lower chassis. This was usually solved by perforating the tops and bottoms of chassis to obtain good vertical cooling. However, new network equipment-building standards ("NEBS") by Bell Atlantic and other RBOC companies discourage the design of complete vertical cooling because fire in lower chassis can easily pass through to upper chassis. Therefore, most chassis are now designed with substantially solid tops, and chassis are stacked in a rack with gaps or vent hoods between them. Usually, the gaps between chassis are 1.75"-3.5" (1.75" is referred to herein as one "rack unit"). And since space is at a premium when stacking and arranging telecommunication equipment, this wastes valuable space.

SUMMARY OF THE INVENTION

Since the challenges in the field of telecommunications continue to increase with demands for more and better techniques having greater flexibility and adaptability, a need has arisen for a new system and method for housing telecommunications equipment. In accordance with the present invention, a system and method for housing telecommunications equipment is provided that substantially eliminates or reduces disadvantages and problems associated with previously developed systems and methods.

A system for housing telecommunications equipment is disclosed. The system comprises a plurality of vertically disposed chassis housing the telecommunications equipment, each chassis having a top that is substantially closed, first and second ends, first and second sides, and a base, wherein the top of each chassis is adapted to receive the base of an adjacent chassis. At least one vent is formed in each chassis adjacent the base for allowing air to enter the chassis. The vent is disposed between the base and a portion of the chassis selected from the group consisting of either of the first end, the second end, the first side, and the second side, and the vent is nonplanar in relation to that portion. More specifically, the chassis may be vertically disposed with substantially zero gap, and the vent member may be either an angled vent member or a notched vent member.

A method for housing telecommunications equipment is disclosed. The method comprises two steps. Step one calls for vertically disposing a plurality of chassis, each chassis housing the telecommunications equipment and having a top that is substantially closed, first and second ends, first and second sides, and a base. The top of each chassis is adapted

to receive the base of an adjacent chassis. Step two requires forming at least one vent in each chassis adjacent the base, wherein the vent is operable to allow air to enter the chassis. The vent is disposed between the base and a portion of the chassis selected from the group consisting of either of the first end, the second end, the first side, and the second side, and the vent is nonplanar in relation to that portion. More specifically, the chassis may be vertically disposed with substantially zero gap, and the vent member may be either an angled vent member or a notched vent member.

Embodiments of the invention provide numerous technical advantages. For example, a technical advantage of one embodiment is that valuable central office space can be saved by closely stacking chassis in a rack while still achieving desired cooling of the chassis. Since in one embodiment, vents in the chassis are either angled or notched, air can enter near the base of each chassis even though the chassis are closely stacked together. If only one chassis exists, this one chassis can be placed on a solid support, such as a floor or table, while still achieving the desired cooling.

Another technical advantage of an embodiment of the present invention is that the desired cooling of chassis, along with the desired close stacking of chassis, can be achieved in a manner that complies with new network equipment-building standards ("NEBS") fire-spreading criteria.

An additional technical advantage of an embodiment of the present invention is that a myriad of designs can be used for the vent depending upon what type of cooling is desired for a particular chassis arrangement.

Other technical advantages are readily apparent to one skilled in the art from the following figures, descriptions, and claims.

BRIEF DESCRIPTION OF THE DRAWINGS

For a more complete understanding of the invention, and for further features and advantages, reference is now made to the following description, taken in conjunction with the accompanying drawings, in which:

FIG. 1A is a front elevational view illustrating one system for housing telecommunications equipment useful in the practice of the present invention;

FIG. 1B is a side elevational view illustrating one system for housing telecommunications equipment useful in the practice of the present invention;

FIG. 2A illustrates one housing system having angled vent members and resting on a support; and

FIG. 2B illustrates another housing system having notched vent members and resting on a support.

DETAILED DESCRIPTION OF EMBODIMENTS OF THE INVENTION

Embodiments of the present invention and its advantages are best understood by referring now to FIGS. 1A, 1B, 2A and 2B of the drawings, in which like numerals refer to like parts.

FIGS. 1A and 1B are front and side elevational views illustrating a system **100** for housing telecommunications equipment **102** in accordance with one embodiment of the present invention. Telecommunications equipment **102** may be any type of telecommunications equipment stored in a chassis; however, in this example, telecommunications equipment **102** is equipment utilized in a central office environment, or similar environment, such as an ATM switch or a DSLAM. In one embodiment, system **100**

comprises a plurality of chassis **104** stacked in an equipment frame (not shown). In this example, telecommunications chassis **104** has a substantially solid top **106**, first end **108**, second end **110**, first and second sides **112**, and a base **114**, and are made of a lightweight material such as steel, other metals such as aluminum, or other materials which are fire resistant; however, other configurations and materials may be used.

As shown best in FIG. 1B, chassis **104** comprises at least one vent **116** located adjacent base **114** for allowing air to enter chassis **104** via apertures **118** (FIG. 1A). Chassis **104** may also have at least one intake vent **124** (FIG. 1B) located on one or both sides **112** for allowing air to enter chassis **104**; however, intake vent **124** is not required. Vent **116**, which is described in detail below, allows air to enter the internal portion of chassis **104** to cool telecommunications equipment **102**. Heated air inside chassis **104** exits via exhaust vents **120**, as can be seen in FIG. 1B. In this embodiment, exhaust vents **120** are integral with either the sides **112**, first end **108**, or second end **110** of chassis **104**; however, exhaust vents **120** may also be integral with top **106** of chassis **104**, depending upon the type and configuration of telecommunications equipment **102** in chassis **104**. Additionally, exhaust vents **120** may be attached to these components in a non-integral fashion. The air that enters chassis **104** through apertures **118** in vent **116** may be natural convection ambient air or may be forced air, such as air forced with a fan. Apertures **118** may be formed in any desired configuration, such as circular, hexagonal, oval or square, and in this example provide a total area of apertures sufficient to meet the cooling requirement for a particular heat load generated by telecommunications equipment **102** in chassis **104**. In this example, the total area of apertures **118** in vent **116** is greater than the total area of apertures in exhaust vents **120**. Vent **116** is adjacent base **114** of chassis **104** and may be configured as angled vent members as shown in FIG. 2A or notched vent members as shown in FIG. 2B.

FIG. 2A illustrates chassis **104** with angled vent members **116**. Chassis **104** is shown in FIG. 2A to be supported by a support **122**, which can be any type of support such as a floor, table, or other solid surface. Vents **116** are formed in chassis **104** such that vents **116** angle upward from an intermediate portion of base **114** and couple to either first end **108**, second end **110**, or side **112** of chassis **104**. As can be seen in FIG. 2A, this results in a right triangle formed by angled vent member **116**, the surface of support **122**, and the imaginary vertical leg normal to the surface of support **122**. This right triangle can be any desired configuration depending upon the type of cooling required for chassis **104**. As described below, the “angling” of vent members **116** allows chassis **104** to be stacked upon one another with a gap less than 1.75 inches and down to 0.00 inches, while still obtaining the desired or required cooling. In addition, the smaller the gap, the greater the space that is saved. The angling of vent members **116** provide a further advantage in that more space is available inside chassis **104** for telecommunications equipment **102**. An alternative arrangement for vent **116** of chassis **104** is to have notched vent members **116** as shown in FIG. 2B.

FIG. 2B illustrates chassis **104** with notched vent members **116**. As in FIG. 2A, FIG. 2B shows chassis **104** resting on support **122**. Notched vent members **116** have two or more venting surfaces arranged in any desired configuration. For example, notched vent members **116** may have two venting surfaces that form an angle of 90° as shown in FIG. 2B, or may have two or more venting surfaces that form

angles greater than, or less than, 90°. In any configuration, the total area of apertures **118** in vents **116** may be designed based on how much cooling is required for a particular heat load generated by telecommunications equipment **102** inside chassis **104**. As described below, the “notching” of vent members **116** allows chassis **104** to be stacked upon one another with a gap less than 1.75 inches and down to 0.00 inches, while still obtaining the desired or required cooling. In addition, the smaller the gap, the greater the space that is saved. The notching of vent members **116** provide a further advantage in that more space is available inside chassis **104** for telecommunications equipment **102**.

As can be seen in either FIG. 2A or FIG. 2B, chassis **104** rests on support **122** with substantially no gap in between. Vents **116** facilitate this by allowing air to enter chassis **104** while chassis **104** rests on support **122**, or rests upon another chassis **104** as shown in FIGS. 1A and 1B. This direct stacking upon either support **122** or another chassis **104** is desirable because it saves valuable space, which is at a premium in, for example, central office environments. The present invention reduces to zero, in some embodiments, the gap between chassis stacked on top of each other, such as chassis **104**. In conventional systems, a gap of 1.75" to 3.5" (one to two rack units) between adjacent chassis is maintained because these gaps are the minimum required to provide the required cooling. Gaps less than 1.75" facilitate preheating of upper chassis and may result in violations of industry standards. Vents **116** are also shown in FIG. 2A and FIG. 2B to be located at the lower edge of either first end **108** or second end **110**. However, vents **116** may also be located on one or both sides **112** of chassis **104**.

In operation, a plurality of chassis **104** are stacked in an equipment frame **101** as shown in FIG. 1A. FIGS. 1B, 2A, and 2B show the stacking of the plurality of chassis **104** without equipment frame **101**. At least one vent **116** is formed in each chassis **104** to allow air to enter the chassis **104** to cool telecommunications equipment **102** contained in chassis **104**. Chassis **104** is stacked upon one another in the frame **101** with a gap **150** less than 1.75 inches, and may be stacked with a substantially zero gap. As mentioned previously, the smaller the gap, the greater the space saved. Either natural convection ambient air or forced air enters vents **116** to cool telecommunications equipment **102** and chassis **104**, and the heated air exits exhaust vents **120**, which are contained in this embodiment in either sides **112**, first end **108**, second end **110**, or top **106**. Alternatively, if a single chassis **104** is used, such as shown in FIG. 2A or 2B, then chassis **104** is normally placed upon support **122** with a substantially zero gap **150** between base **114** and support **122**. In this case, vents **116** allow air to enter chassis **104** to cool telecommunications equipment **102**. Heated air exits exhaust vents **120** as described above.

Although an embodiment of the invention and its advantages are described in detail, a person skilled in the art could make various alternations, additions, and omissions without departing from the spirit and scope of the present invention as defined by the appended claims.

What is claimed is:

1. A system for housing telecommunications equipment, comprising:

a plurality of vertically disposed chassis housing the telecommunications equipment, each chassis having a top that is substantially closed, first and second sides, first and second ends, and a base, wherein the top of each chassis is adapted to receive the base of an adjacent chassis;

at least one vent formed in each chassis adjacent the base, wherein the vent is operable to allow air to enter the chassis; and

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wherein the vent is disposed between the base and a portion of the chassis selected from the group consisting of the first side, the second side, the first end, and the second end, and wherein the vent is nonplanar in relation to the portion, wherein the vent is a notched vent member coupled to the base and the portion, wherein the notched vent member has two or more venting surfaces.

2. The system of claim 1, wherein at least one set of adjacent chassis in the plurality of vertically disposed chassis are separated by a gap that is less than 1.75 inches.

3. The system of claim 1, wherein at least one set of adjacent chassis are stacked such that the top of a first chassis is in direct contact with the base of a second chassis with no gap therebetween apart from the vent of the second chassis.

4. The system of claim 1, wherein the vent has a plurality of apertures.

5. The system of claim 1, wherein the two or more venting surfaces angle toward the portion.

6. The system of claim 1, wherein the notched vent member coupled to the base and the portion has two venting surfaces forming a ninety degree angle.

7. A system for housing telecommunications equipment, comprising:

a chassis housing the telecommunications equipment and having a top that is substantially closed, first and second sides, first and second ends, and a base;

at least one vent formed in the chassis adjacent the base, wherein the vent is operable to allow air to enter the chassis; and

wherein the vent is disposed between the base and a portion of the chassis selected from the group consisting of the first side, the second side, the first end, and the second end, and wherein the vent is nonplanar in relation to the portion, wherein the vent is a notched vent member coupled to the base and the portion, wherein the notched vent member has two or more venting surfaces.

8. The system of claim 7 further comprising:

a support underneath the base of the chassis, wherein the support is operable to support the chassis.

9. The system of claim 8, wherein the chassis and the support are separated by a gap that is less than 1.75 inches exists.

10. The system of claim 8, wherein the chassis and the support have no gap therebetween apart from the vent.

11. The system of claim 7, wherein the vent has a plurality of apertures.

12. The system of claim 7, wherein the two or more venting surfaces angle toward the portion.

13. The system of claim 7, wherein the notched vent member coupled to the base and the portion includes two venting surfaces forming a ninety degree angle.

14. A method for housing telecommunications equipment, the method comprising:

vertically disposing a plurality of chassis, each chassis housing the telecommunications equipment and having a top that is substantially closed, first and second sides, first and second ends, and a base, wherein the top of each chassis is adapted to receive the base of an adjacent chassis; and

forming at least one vent in each chassis adjacent the base, wherein the vent is operable to allow air to enter the

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chassis, and wherein the vent is disposed between the base and a portion of the chassis selected from the group consisting of the first side, the second side, the first end, and the second end, and wherein the vent is nonplanar in relation to the portion, wherein the vent is a notched vent member coupled to the base and the portion, wherein the notched vent member has two or more venting surfaces.

15. The method of claim 14, wherein vertically disposing a plurality of chassis comprises separating at least one set of adjacent chassis by a gap that is less than 1.75 inches.

16. The method of claim 14, wherein vertically disposing a plurality of chassis comprises stacking at least one set of adjacent chassis such that there is no gap therebetween apart from the vent.

17. The method of claim 14, further comprising:

providing the vent with a plurality of apertures.

18. The method of claim 14, wherein the two or more venting surfaces angle toward the portion.

19. The method of claim 14, wherein the notched vent member coupled to the base and the portion includes two venting surfaces forming a ninety degree angle.

20. A system for housing telecommunications equipment, comprising:

a plurality of vertically disposed chassis, each chassis housing the telecommunications equipment and having a top substantially closed, first and second sides, first and second ends, and a base, wherein the top of each chassis is adapted to receive the base of an adjacent chassis;

a first vent formed in each chassis and having a lower end and an upper end, the lower end coupled to the base and the upper end coupled to the first end of the chassis such that the front vent is nonplanar in relation to the first end;

a second vent formed in each chassis and having a lower end and an upper end, the lower end coupled to the base and the upper end coupled to the second end of the chassis such that the rear vent is nonplanar in relation to the second end; and wherein the first and second vents are operable to allow air to enter the chassis, wherein the first and second vents are notched vent members coupled to the base and the respective first and second ends, wherein the notched vent member has two or more venting surfaces.

21. The system of claim 20, wherein at least one set of adjacent chassis in the plurality of vertically disposed chassis are separated by a gap that is less than 1.75 inches.

22. The system of claim 20, wherein at least one set of adjacent chassis in the plurality of vertically disposed chassis are stacked such that the top of a first chassis is in direct contact with the base of a second chassis with no gap therebetween apart from the first and second vents of the second chassis.

23. The system of claim 20, wherein the first and second vents each have a plurality of apertures.

24. The system of claim 20, wherein the two or more venting surfaces angle toward the base.

25. The system of claim 20, wherein the notched vent members coupled to the base include two venting surfaces forming a ninety degree angle.

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